



Estimates of Abundance of Barton Springs Salamanders at Eliza Spring using Capture-Mark-Recapture

DR-18-03

December 19, 2017

Nathan F. Bendik

City of Austin

Watershed Protection Department, Environmental Resource Management Division

We performed ten Capture-Mark-Recapture (CMR) surveys at Eliza Spring for Barton Springs salamanders from October 2014 through September 2017. Each survey consisted of a primary period during which secondary surveys were repeated three times over 10 days. Within the primary periods we assumed the population was closed to emigrants, immigrants, births and deaths. Primary periods were on average three months apart (two survey periods were missed). Between primary periods, the population is open to demographic changes. Using this survey structure, referred to as the robust-design (Pollock 1982) we can estimate both the probabilities of capture (p) and recapture (c) (and thus, enabling estimation of abundance) as well as the probabilities of apparent survival (ϕ) and temporary emigration (γ' and γ'') (Kendall, Nichols & Hines 1997). Here, we are primarily concerned with estimating abundance. Estimation was performed using program MARK version 8.2. We compared models with and without behavioral effects on recapture, and all parameters were allowed to vary temporally. Models with Markovian temporary emigration ($\gamma' \neq \gamma''$) and without behavioral effects on capture ($p = c$) outperformed those with random temporary emigration ($\gamma' = \gamma''$) with behavioral effects of capture ($p \neq c$).

Estimates of abundance are provided in Table 1. These values represent the total population size (including all size classes) that occurs at the surface of Eliza Spring.

Table 1. Estimates of abundance (\hat{N}) from the model $\phi(\text{time})$, $\gamma(\text{Markov})$, $p=c(\text{period, time})$ with standard errors (SE) and 95% lower and upper confidence limits (LCL and UCL, respectively).

PERIOD	\hat{N}	SE	LCL	UCL
Oct14	301	19	271	348
Feb15	156	8.0	145	177
Aug15	119	4.4	113	131
Nov15	121	6.2	112	138
Mar16	194	11	178	221
Jul16	129	11	113	159
Aug16	139	10	124	165
Nov16	190	11	173	218
Feb17	325	21	292	375
Sep17	91	5.5	83	106

Throughout the study period, the average conditional capture probability was 0.40 (SE = 0.02), although we did not account for differences in detection among size classes. The average detection probability was higher if we consider the first day of each sampling period ($\overline{p^{first}} = 0.46$), indicating that subsequent days within each period resulted in lower detection probabilities. The first day of sampling may be analogous to a count survey, because the site is a priori undisturbed and salamanders are observed for the first time (since the previous primary period). We may therefore assume that the average first-day conditional capture probabilities are representative of capture probabilities if the CMR survey were a count survey instead. Thus, it is possible (with some assumptions) to approximate the local population size based on counts and estimates conditional capture probability (see below).

Temporary emigration represents the proportion of the population that is unavailable for capture during a primary period. In the context Barton Springs salamanders inhabiting Eliza Spring, temporary emigration estimates reflect the proportion of the population beneath the surface. We can say this with confidence because the stream originates within an amphitheater with a concrete floor and (until recently) drained through a pipe. Thus, migration to or from downstream habitat is not possible, and the concrete floor forms a clear boundary between the surface and subsurface. When temporary emigration is Markovian, whether an individual is absent is dependent upon its previous state, and is represented by parameters γ' and γ'' . The parameter γ'' indicates the proportion of individuals who left the study site that were not temporary migrants (i.e., they were present) during the previous period. The parameter γ' represents the proportion of individuals who stayed away; these were temporary migrants during the previous period. When $\gamma'' > \gamma'$, this implies that more animals outside the study area in period i will be present and available for capture in subsequent periods than when $\gamma'' < \gamma'$. When $\gamma'' = \gamma'$, temporary migration is said to be “random”. In general, high estimates of γ indicate that a large proportion of the population is unavailable for capture, i.e., they are underground, and this appears to have been the case at Eliza Spring (Table 2).

Table 2. Estimates of temporary emigration (γ) and their standard errors from the model $\varphi(\text{time})$, $\gamma(\text{Markov})$, $p=c(\text{period}, \text{time})$. Estimates for the last period are not shown because they are confounded with estimates of apparent survival.

Period	$\hat{\gamma}''$	$\hat{\gamma}'$
Feb15	0.70 (0.87)	
Aug15	0.87 (0.05)	0.85 (0.08)
Nov15	0.88 (0.04)	0.88 (0.05)
Mar16	0.40 (0.11)	0.76 (0.07)
Jul16	0.92 (0.03)	0.88 (0.05)
Aug16	0.62 (0.06)	0.96 (0.02)
Nov16	0.52 (0.26)	0.67 (0.17)
Feb17	0.69 (0.05)	0.63 (0.29)

Estimates of capture probability only reflect the probability of capture conditional upon the animal being present at the surface. In contrast, the effective capture probability includes the probability of capture for all animals within the superpopulation. The superpopulation includes all animals that are

associated with the surface population and have some non-negligible probability of being captured during the study (i.e., they occur at the surface at some point). The effective capture probability $p^0 = (1 - \gamma)p^*$, where p^* is the conditional probability of capture (Kendall et al. 1997). Thus, when emigration is random (i.e., $\gamma' = \gamma''$), the size of the superpopulation can be approximated as $N^0 = n/p^0$, where n is the number of animals captured.

We calculated effective capture probability and superpopulation size for the periods February 2015 through February 2017 assuming either random or Markovian temporary emigration. For the initial period for the Markovian case, we assumed $(\gamma' \approx \gamma'')$, and this calculation was straightforward as $p^0 = (1 - \gamma)p^*$ and $N^0 = n/p^0$ (as above). For subsequent periods for the Markovian case, where $(\gamma' \neq \gamma'')$, we estimated the superpopulation size by calculating the individual contributions of the superpopulation and the local population from period i to those at period $i+1$, as follows.

We define X_i as the sum of the individuals that were present within the local population at time $i-1$ that remained there and survived until time i , plus the individuals that were not in the local population at time $i-1$ but entered it and survived until time i :

$$X_i = (1 - \hat{\gamma}'_i)(\hat{N}_{i-1}^0 - \hat{N}_{i-1})\hat{\phi}_i + (1 - \hat{\gamma}''_i)(\hat{N}_{i-1})\hat{\phi}_i.$$

Similarly, we define Y_i as the sum of individuals that were not present within the local population at time i that remained absent from it and survived time $i+1$ plus the individuals that were in the local population at time i but left it and survived at time $i+1$:

$$Y_i = (\hat{\gamma}'_i)(\hat{N}_{i-1}^0 - \hat{N}_{i-1})\hat{\phi}_i + (\hat{\gamma}''_i)(\hat{N}_{i-1})\hat{\phi}_i.$$

Thus, $X_i + Y_i$ accounts for the sum of all individuals that persisted from the previous period that remain in the superpopulation. However, it does not account for new entrants (from immigration or births) to the superpopulation. Define the number of new entrants to the local population (\hat{N}_{i+1}) as B_i^X and the number of new entrants to the non-local population ($\hat{N}_{i+1}^0 - \hat{N}_{i+1}$) as B_i^Y . Therefore the size of the total superpopulation for the next period is calculated as

$$\hat{N}_i^0 = X_i + Y_i + B_i^X + B_i^Y.$$

B_i^X was calculated from the difference of \hat{N}_i and X_i , the former of which is output as an estimate from MARK and the latter of which can be calculated from the parameter estimates. In the case of random emigration, we can estimate both the size of the local and the superpopulations, and therefore calculate the number of entrants for each portion of the population by subtraction. It can then be shown, in the case of random emigration, that $X_i/Y_i = B_i^X/B_i^Y = (1 - \gamma)/\gamma$. Thus, we also assume that this relationship holds for the case of Markovian emigration, and can therefore calculate B_i^Y .

Substituting the parameters estimated from the model into the above equations for X_i, Y_i, B_i^X and B_i^Y , the superpopulation equation simplifies to:

$$\hat{N}_i^0 = \hat{N}_i + \frac{\gamma_i * \hat{N}_i}{X_i}$$

The effective capture probability was then calculated as n_i/\hat{N}_i^0 . In Table 3, we provide estimates for the superpopulation size and effective capture probabilities using the proposed ad hoc method for the Markovian temporary emigration case in addition to the random temporary emigration case. The difference is that the random temporary emigration model was not as well supported by the data ($\Delta\text{AIC} = 27$).

Table 3. Estimates of superpopulation size (\hat{N}_i^0) and effective capture probability (\hat{p}^0) under random and Markovian temporary emigration models.

	Random		Markovian	
	\hat{N}_i^0	\hat{p}^0	\hat{N}_i^0	\hat{p}^0
Feb15	532	0.24	524*	0.25*
Aug15	881	0.12	846	0.13
Nov15	725	0.14	1002	0.10
Mar16	499	0.31	465	0.33
Jul16	888	0.11	1253	0.08
Aug16	751	0.14	1300	0.08
Nov16	585	0.25	476	0.31
Feb17	1059	0.21	974	0.23
Average	740	0.19	855	0.19

*For the initial period, we assumed $\gamma'' = \gamma'$.

Because a large proportion of the population was frequently estimated to be unavailable for capture for the entire study period, it is likely that individuals at the surface (as estimated in Table 1) are only a fraction of the population that inhabits the springs (e.g., 19% on average; Table 3).

Using CMR Estimates and Counts to Calculate the Size of the Superpopulation

It is possible to approximate the superpopulation size based on counts and estimates of effective capture probability. Superpopulation size can be calculated as n/p^0 , where n is the number of animals captured during a given survey and p^0 is the effective capture probability. In principle, counts (c) should yield around the same number of salamanders as those captured, thus $c \approx n$. This is because we perform a drive survey for both counting and for capturing salamanders and the only difference between the two techniques is the capturing of individuals vs. counting them as they pass downstream. In practice, this assumption will be incorrect when individuals are counted more than once in the field (e.g., if they moved from downstream to upstream without us knowing), and thus $c > n$. Another source of bias could result from animals being observed in the field but not captured (this would bias counts high), with $c < n$. However, because three surveys are performed in a row to estimate detection probabilities, missed individuals may be indirectly accounted for (for example, if they are captured the following day). Currently we do not have any data to validate the relationship between c and n , although, in general, we believe $c \approx n$ is a reasonable assumption to make.

A more tenuous assumption is that effective capture probabilities are applicable under different environmental and survey conditions, different time periods, or for different population sizes. For example, habitat conditions may influence both availability (how much of the population is at the surface) and detection (our ability to capture/observe available individuals at the surface), each of which contribute to effective capture probability. We have not yet examined the influence of habitat

conditions (e.g., sedimentation, algae cover) on detection or availability, although an analysis is forthcoming. Additionally, detection and availability may vary between sites due to differences in survey methods or habitat. For example, we snorkel in Eliza (depth = 1 ft), dive in Parthenia (depth = 10–15 ft), snorkel and dive in Old Mill (depth = 0 – 3 ft), and wade in Upper Barton Spring (depth < 0.5'). Differences in the size of springs and flow regime may also result in differences of availability for each population. Currently, we only have estimates of availability and detection for Eliza Spring. Even if we assume conditions are similar across sites for a given period of time, only count data are available for periods prior to Oct 2014. This means that if we apply an average effective capture probability estimated from 2014–2017 to a different time period, we assume that conditions are similar enough (both for availability and detection). One thing to consider, for example, is that some counts from 2004–2014 at Eliza were occasionally much higher (e.g., by an order of magnitude) than any capture totals or estimates of local abundance from 2014–2017. Would availability have been higher during those periods because more of the population was at the surface? We do not know. Finally, even if all the above assumptions are correct, using average values for any quantity would only be representative of an average condition, and therefore not necessarily be accurate during any particular period of time.

In summary, the following assumptions are required for using the proposed approach to estimate superpopulation size from count data (note that this list is not exhaustive and excludes assumptions of CMR methods):

1. The number of individuals counted is equal to the number of individuals captured (or that would have been captured), $c = n$.
2. Probabilities (or average probabilities) of capture and temporary emigration are the same at all sites for a given time.
3. Probabilities (or average probabilities) of capture and temporary emigration from Eliza Spring 2014–2017 are the same for previous time periods (and at all sites). This includes the assumption that variation in site conditions and population sizes are represented in the 2014–2017 data or do not vary from that range or are irrelevant to parameter estimates.

Given this list of assumptions, some of which are very strong, it is our opinion that they are not as unreasonable as the assumption that counts equal population size or superpopulation size. Therefore any method using some estimates from CMR data (whether it be to estimate local population size or superpopulation size) to apply to different sites or time periods where only count data are available is preferable to methods that only use an uncorrected count. All indications are that salamanders frequently occupy subterranean habitat and that a fairly large proportion of the population associated with the springs is unavailable for capture. If estimate of the superpopulation are required, to our knowledge, using CMR estimates as described here is the best method available.

Available Count Data

Count surveys were performed as early as 1993 at Parthenia Spring, however the survey methods periodically changed, from transects, to transects with “hot spots” to just “hot spots” and finally to a full exhaustive search for the first 40' in front of the spring in 2003. Surveys at Old Mill Spring and Eliza Spring were haphazard, and surveys at Upper Barton Spring did not begin until 1997 (when

they were first discovered there). Count surveys performed by the City of Austin at all four spring sites at Barton Springs between 2004–2014 are the most consistently collected count data for these sites and are provided (see Appendix). The yearmon column contains the year and month the data were collected. The following columns contain the sums of counts at each site for different size classes. The suffixes sm1, btw12, and lg2 correspond to the size classes < 1 in, 1–2 in, and > 2 in. The total column contains the total counts for all three size classes, plus any additional individuals not assigned to a size class.

After 2014, most surveys were performed as capture-mark-recapture (CMR) surveys. With the exception of surveys at Eliza Spring, these CMR surveys were done once every quarter and resulted in so few recaptures that estimating parameters for even the simplest CMR model was impossible. Thus, these data are effectively counts as well. However, given the low recapture rates, we can assume that either these populations have low survival or lots of emigration. If required, these data can be obtained directly from our permit reports (previously referenced and linked in our comments) or from the m-array tables below.

Few data are available for densities of Barton Springs or Austin Blind salamanders within the aquifer. In Table 1 we report the results of past surveys performed by the City of Austin Balcones Canyonlands Preserve staff at Blowing Sink, the only subterranean habitat within the aquifer that is directly accessible by people and is inhabited by Barton Springs salamanders. One strategy could be to apply these estimates of density to a larger area within the aquifer, if this area could be calculated based on aquifer porosity, conduit floor area, or other hydrogeologic information. For example, assuming a 1.5m wide conduit in a straight-line from Blowing Sink to Barton Springs (11,265 m) and multiplying by the average density of salamanders in Blowing Sink (0.0696 sal/m²) yields an estimate of approximately 1,176 salamanders. However, it is unlikely that salamander density is homogenous (in space or time), and may be more dense near areas with surface connectivity, such as caves like Blowing Sink or spring outlets. Therefore, one might estimate the number and extent of these areas throughout the recharge or artesian zones of the Barton Springs segment, and apply the Blowing Sink average densities to yield an estimated aquifer population size. This would be preferable to a method assuming the aquifer is not inhabited by salamanders or that their extent is limited to the near surface, because neither assumption is correct.

Table 1. Survey results for Barton Springs Salamanders for Blowing Sink Cave. Density was estimated using an approximate searched cave area of ca. 41 m².

Date	Cave Zone	Observers	Eurycea Total (Count)	Approximate density (sal/m ²)
2/23/2012	[3]		1	0.02439
10/14/2010	[3]	M. Sanders	1	0.02439
5/26/2010	[Cursory Survey]	M. Sanders	6	0.14634
3/28/2010	[Cursory Survey]	M. Sanders	1	0.02439
2/20/2010	[Cursory Survey]	M. Sanders	4	0.09756
12/19/2009	[Cursory Survey On Entire Cave]	M. Sanders	5	0.12195
5/2/2006	[No Dsm]	M. Sanders, A. Gluesenkamp	2	0.04878

References

- Kendall, W., Nichols, J. & Hines, J. (1997) Estimating temporary emigration using capture-recapture data with Pollock's robust design. *Ecology*, **78**, 563–578.
- Pollock, K.H.K. (1982) A capture-recapture design robust to unequal probability of capture. *The Journal of Wildlife Management*, **46**, 752–757.

The following tables contain capture-recapture data in the m-array format. The Released column contains the number of unique individuals captured, photographed and released, including those initially released and ones released after recapture from a previous cohort. The remaining columns are the number first recaptured in each of the following occasions. Once recaptured they become one of the following rows (i.e., release-recapture pairs).

Eliza Primary Session Encounters

Month-Yr	Occasion	Released	2	3	4	5	6	7	8	9	10	Total
Oct14	1	209	24	5	3	1	1	1	4	1	0	40
Feb15	2	130	8	6	8	2	0	2	2	0		28
Aug15	3	108	10	13	1	5	4	3	0			36
Nov15	4	104	34	7	0	2	0	1				44
Mar16	5	154	9	4	16	15	0					44
Jul16	6	94	27	6	4	1						38
Aug16	7	106	16	6	0							22
Nov16	8	147	31	2								33
Feb17	9	222	3									3
Sep17	10	77										0

Parthenia Encounters

Month-Yr	Occasion	Released	2	3	4	5	6	7	8	Total
Feb16*	1	9	0	0	0	0	0	0	0	0
Aug16	2	3	0	0	0	0	0	0	0	0
Nov16*	3	4	0	0	0	0	0			0
Nov16	4	65	2	0	0	0				2
Feb17	5	17	1	0	0					1
May17	6	18	0	0						0
Aug17	7	61	1							1

*stranded salamander surveys from fissures during drawdown

Old Mill Encounters

Month-Yr	Occasion	Released	2	3	4	5	6	7	Total
Mar16	1	2	0	0	0	0	0	0	0
May16	2	3	0	0	0	0	0	0	0
Aug16	3	3	0	0	0	0	0	0	0
Nov16	4	2	0	0	0	0	0	0	0
Feb17	5	4	0	0	0	0	0	0	0
May17	6	1	0	0	0	0	0	0	0

Upper Barton Spring Encounters

Month-Yr	Occasion	Released	2	3	4	5	6	7	8	9	10	11	12	13	Total
Dec13	1	6	1	0	0	0	0	0	0	0	0	0	0	0	1
Jan14	2	4	0	2	0	0	0	0	0	0	0	0	0	0	2
Mar14	3	45	0	0	0	3	0	2	0	0	0	0	0	0	5
Jun14	4	15	0	0	0	0	1	0	0	0	0	0	0	0	1
Dec14	5	19	0	0	0	0	2	0	0	0	1	0	0	0	2
Feb15	6	8	0	0	0	0	0	2	0	0	0	0	0	0	2
Apr15	7	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct15	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb16	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0
May16	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov17	11	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar17	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix: Count data from Parthenia (BSP), Eliza, Sunken Garden/Old Mill pool (SG) and stream (SG stream) and Upper Barton Spring (UBS).

Yearmons	BSP_sm1	BSP_lg2	BSP_bt12	BSP_total	Eliza_sm1	Eliza_lg2	Eliza_bt12	Eliza_total
2004-01	33	4	26	63	91	16	124	231
2004-02	2	1	1	4	90	40	167	297
2004-03	9	0	1	10	124	34	247	412
2004-04	3	0	3	6	NA	NA	NA	NA
2004-05	4	0	4	8	166	96	332	601
2004-06	NA	NA	NA	NA	NA	NA	NA	NA
2004-07	0	0	0	0	NA	NA	NA	NA
2004-08	3	0	2	5	51	124	167	342
2004-09	4	0	2	6	97	127	86	310
2004-10	NA	NA	NA	NA	64	91	102	262
2004-11	NA	NA	NA	NA	NA	NA	NA	NA
2004-12	1	1	0	2	NA	NA	NA	NA
2005-01	NA	NA	NA	NA	7	52	87	146
2005-02	NA	NA	NA	NA	NA	NA	NA	NA
2005-03	NA	NA	NA	NA	NA	NA	NA	NA
2005-04	1	0	1	2	27	77	80	186
2005-05	NA	NA	NA	NA	74	83	91	272
2005-06	4	0	0	4	71	76	73	223
2005-07	5	1	4	10	72	34	54	166
2005-08	NA	NA	NA	NA	135	85	148	376
2005-09	10	8	26	45	140	95	227	483
2005-10	3	0	0	3	123	167	284	577
2005-11	6	5	13	26	105	329	237	673
2005-12	6	5	4	15	171	200	216	589
2006-01	NA	NA	NA	NA	280	120	223	625
2006-02	4.5	2.5	4.5	11.5	NA	NA	NA	NA
2006-03	NA	NA	NA	NA	NA	NA	NA	NA
2006-04	8	17	23	48	101	238	399	738
2006-05	11	0	0	11	123	152	174	457
2006-06	1	0	3	4	158	237	232	627
2006-07	0	0	5	5	110	94	188	420
2006-08	1	0	0	1	127	82	242	451
2006-09	0	0	1	1	34	55	120	216
2006-10	0	0	0	0	44	63	119	231
2006-11	NA	NA	NA	NA	64	134	149	350

2006-12	NA	NA	NA	NA	86	181	152	421
2007-01	NA	NA	NA	NA	135	337	203	683
2007-02	NA	NA	NA	NA	179	227	287	701
2007-03	0	0	0	0	67	87	124	280
2007-04	0	0	0	0	70	224	203	502
2007-05	NA	NA	NA	NA	89	365	189	656
2007-06	NA	NA	NA	NA	59	187	122	368
2007-07	NA	NA	NA	NA	74	123	117	315
2007-08	3	1	1	5	40	142	129	318
2007-09	1	2	1	4	NA	NA	NA	NA
2007-10	1	0	2	4	18	242	102	364
2007-11	2	1	4	7	25	194	76	301
2007-12	2	0	3	5	39	149	139	329
2008-01	NA	NA	NA	NA	117	135	103	355
2008-02	17	2	13	32	178	200	76	460
2008-03	10	2	14	26	444	192	254	898
2008-04	NA	NA	NA	NA	568	256	386	1234
2008-05	11.5	7	10.5	29	488	156	522	1193
2008-06	23	1	11	35	422	138	535	1117
2008-07	1	0	21	22	295	69	465	833
2008-08	2	2	10	14	195	91	342	642
2008-09	NA	NA	NA	NA	122	78	376	586
2008-10	NA	NA	NA	NA	119	82	345	560
2008-11	NA	NA	NA	NA	42	66	207	328
2008-12	3	1	7	11	19	79	123	231
2009-01	NA	NA	NA	NA	27	42	99	172
2009-02	0	1	1	2	37	40	122	203
2009-03	NA	NA	NA	NA	NA	NA	NA	NA
2009-04	0	0	0	0	12	25	57	102
2009-05	1	0	3	4	16	49	106	173
2009-06	0	0	0	0	13	36	100	151
2009-07	NA	NA	NA	NA	5	20	44	69
2009-08	1	0	0	1	3	15	17	35
2009-09	NA	NA	NA	NA	4	14	27	45
2009-10	NA	NA	NA	NA	1	134	139	279
2009-11	NA	NA	NA	NA	12	154	230	405
2009-12	4	1	5	10.5	NA	NA	NA	NA
2010-01	NA	NA	NA	NA	9	168	170	360

2010-02	NA	NA	NA	NA	NA	NA	NA	NA
2010-03	0	3	4	7	NA	NA	NA	NA
2010-04	25	13	36	77	0	59	74	151
2010-05	6	6	10	24	18	67	41	131
2010-06	NA	NA	NA	NA	NA	NA	NA	NA
2010-07	10	12	29	54	2	2	8	12
2010-08	NA	NA	NA	NA	9	67	63	149
2010-09	2	1	8	11	NA	NA	NA	NA
2010-10	3	3	2	8	1	64	28	106
2010-11	NA	NA	NA	NA	13	58	47	125
2010-12	7	2	8	19	24	81	47	156
2011-01	NA	NA	NA	NA	9	74	39	126
2011-02	NA	NA	NA	NA	59	111	54	224
2011-03	18	7	23	49.5	76	63	47	189
2011-04	38	2	33	77	79	56	74	211
2011-05	18	2	33	54	55	41	125	226
2011-06	3	2	30	35	17	69	74	169
2011-07	3	3	24	30	21	31	91	144
2011-08	1	2	2	5	9	51	75	140
2011-09	NA	NA	NA	NA	5	31	66	104
2011-10	0	0	4	4	2	23	23	49
2011-11	1	0	1	2	5	25	30	65
2011-12	0	0	1	1	NA	NA	NA	NA
2012-01	NA	NA	NA	NA	NA	NA	NA	NA
2012-02	9	2	7	19	26	71	48	147
2012-03	NA	NA	NA	NA	NA	NA	NA	NA
2012-04	0	0	0	0	11	71	61	147
2012-05	2	0	1	3	NA	NA	NA	NA
2012-06	10	5	30	47	4	40	33	78
2012-07	NA	NA	NA	NA	8	40	26	77
2012-08	5	0	19	27	7	23	22	53
2012-09	0	0	1	1	9	35	51	97
2012-10	5	2	6	15	11	44	29	87
2012-11	9	2	9	20	41	34	72	149
2012-12	41	4	34	80	58	43	74	181
2013-01	19	0	35	54	96	62	136	299
2013-02	19	3	37	60	176	53	189	421
2013-03	38	4	78	120	122	38	265	428

2013-04	15	0	20	35	97	78	354	529
2013-05	26	2	23	51	62	93	353	511
2013-06	7	0	4	11	51	108	268	430
2013-07	9	2	10	22	48	43	201	300
2013-08	NA	NA	NA	NA	20	28	159	208
2013-09	1	0	6	7	10	40	89	144
2013-10	NA	NA	NA	NA	NA	NA	NA	NA
2013-11	0	0	0	0	NA	NA	NA	NA
2013-12	NA	NA	NA	NA	1	40	34	75
2014-01	NA	NA	NA	NA	NA	NA	NA	NA
2014-02	0	2	4	6	0	38	45	84
2014-03	NA	NA	NA	NA	NA	NA	NA	NA
2014-04	1	0	4	5	18	87	48	154
2014-05	NA	NA	NA	NA	NA	NA	NA	NA
2014-06	NA	NA	NA	NA	NA	NA	NA	NA
2014-07	NA	NA	NA	NA	NA	NA	NA	NA
2014-08	NA	NA	NA	NA	NA	NA	NA	NA
2014-09	NA	NA	NA	NA	NA	NA	NA	NA
2014-10	NA	NA	NA	NA	NA	NA	NA	NA
2014-11	NA	NA	NA	NA	NA	NA	NA	NA
2014-12	NA	NA	NA	NA	NA	NA	NA	NA
2015-01	NA	NA	NA	NA	NA	NA	NA	NA
2015-02	NA	NA	NA	NA	NA	NA	NA	NA
2015-03	NA	NA	NA	NA	NA	NA	NA	NA
2015-04	NA	NA	NA	NA	NA	NA	NA	NA
2015-05	NA	NA	NA	NA	NA	NA	NA	NA
2015-06	NA	NA	NA	NA	NA	NA	NA	NA
2015-07	NA	NA	NA	NA	NA	NA	NA	NA
2015-08	NA	NA	NA	NA	NA	NA	NA	NA
2015-09	NA	NA	NA	NA	NA	NA	NA	NA
2015-10	NA	NA	NA	NA	NA	NA	NA	NA
2015-11	NA	NA	NA	NA	NA	NA	NA	NA
2015-12	NA	NA	NA	NA	NA	NA	NA	NA
2016-01	NA	NA	NA	NA	NA	NA	NA	NA
2016-02	NA	NA	NA	NA	NA	NA	NA	NA
2016-03	NA	NA	NA	NA	NA	NA	NA	NA

Yearmons	SG_sm1	SG_lg2	SG_btwn12	SG_total	SG_stream_sm1	SG_stream_lg2	SG_stream_btwn12	SG_stream_total	UBS_sm1	UBS_lg2	UBS_btwn12	UBS_total
2004-01	12	7	19	39	NA	NA	NA	NA	NA	NA	NA	NA
2004-02	5	17	23	45	NA	NA	NA	NA	NA	NA	NA	NA
2004-03	4	18	10	35	NA	NA	NA	NA	1	6	1	10
2004-04	12	14	18	45	NA	NA	NA	NA	NA	NA	NA	NA
2004-05	9	18	40	67	NA	NA	NA	NA	0	6	1	7
2004-06	NA	NA	NA	NA	NA	NA	NA	NA	0	9	2	12
2004-07	2	22	32	56	NA	NA	NA	NA	0	2	1	3
2004-08	3	21	28	52	NA	NA	NA	NA	0	2.5	1.5	4
2004-09	7	21	21	50	NA	NA	NA	NA	0	10	4	14
2004-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004-11	NA	NA	NA	NA	NA	NA	NA	NA	0	2	2	4
2004-12	0	4	1	6	NA	NA	NA	NA	NA	NA	NA	NA
2005-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005-02	1	5	3	10	NA	NA	NA	NA	1	0	2	3
2005-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005-05	2	5	3	10	NA	NA	NA	NA	NA	NA	NA	NA
2005-06	0	0	1	1	0	3	3	6	0	4	2	6
2005-07	0	2	3	5	1	0	4	5	NA	NA	NA	NA
2005-08	10	1	1	13	0	3	3	10	NA	NA	NA	NA
2005-09	4	0	2	7	2	5	6	16	0.5	1.5	4	6
2005-10	2	2	4	8	3	2	4	9	0	0	1	1
2005-11	2	0	1	3	0	0	4	4	NA	NA	NA	NA
2005-12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2006-01	0	1	2	3	NA	NA	NA	NA	NA	NA	NA	NA
2006-02	2	1	0	3	0	0	1	1	NA	NA	NA	NA
2006-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2006-04	0	0	1	1	0	0	0	0	NA	NA	NA	NA
2006-05	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-06	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-07	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-08	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-09	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-10	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2006-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2006-12	NA	NA	NA	NA								
2007-01	NA	NA	NA	NA								
2007-02	0	3	2	5	0	0	0	0	1	2	3	6
2007-03	1	2	1	4	0	0	0	0	NA	NA	NA	NA
2007-04	0	0	1	1	NA	NA	NA	NA	0	1	2	3
2007-05	3	2	1	7	0	0	0	0	4	1	6	11
2007-06	NA	NA	NA	NA								
2007-07	NA	NA	NA	NA								
2007-08	3	3	2	8	NA	NA	NA	NA	0	0	1	1
2007-09	NA	0	1	0	1							
2007-10	0	2	6	8	0	0	1	0	0	1	2	3
2007-11	NA	1.5	3	1	5.5							
2007-12	3	7	2	12	1	0	1	2	NA	NA	NA	NA
2008-01	NA	4	3	6	13							
2008-02	12	12	7	32	4	2	2	8	5	6.5	12.5	24
2008-03	24	5	11	40	0	3	5	11	NA	NA	NA	NA
2008-04	25	5	15	48	41	10	27	78	7	7	16	30
2008-05	12	3	13	30	9	11	32	57	0	2	1	3
2008-06	1	1	3	5	22	9	35	66	NA	NA	NA	NA
2008-07	NA	NA	NA	NA								
2008-08	0	0	0	0	0	1	0	1	NA	NA	NA	NA
2008-09	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2008-10	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2008-11	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2008-12	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-01	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-02	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-03	NA	NA	NA	NA								
2009-04	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-05	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-06	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-07	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-08	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-09	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2009-10	0	0	2	2	0	0	0	0	NA	NA	NA	NA
2009-11	0	3	4	7	0	0	0	0	0	7	8	16

2009-12	0	1	0	1	0	1	0	1	0	1	1	2
2010-01	0	3	1	4	0	3	1	4	6	7	2	16
2010-02	0	0	1	2	0	0	0	0	NA	NA	NA	NA
2010-03	0	3	0	3	0	0	0	0	9	4	4	17
2010-04	0	0	1	1	0	0	0	0	47	3.5	18.5	70.5
2010-05	0	2	0	2	0	0	0	0	NA	NA	NA	NA
2010-06	0	0	1	1	0	0	0	0	17	1	17	39
2010-07	0	0	0	0	0	0	0	0	5	0	26	36
2010-08	0	1	1	2	0	0	0	0	NA	NA	NA	NA
2010-09	NA	3	2	8	14							
2010-10	0	0	1	1	0	0	0	0	NA	NA	NA	NA
2010-11	0	0	0	0	0	0	0	0	0.5	1	4	6
2010-12	0	0	1	1	0	0	0	0	NA	NA	NA	NA
2011-01	3	0	0	3	0	0	0	0	3	4	13	20
2011-02	2	0	2	4	0	0	0	0	NA	NA	NA	NA
2011-03	2	2	0	4	0	1	2	3	1	0	1	2
2011-04	2	0	1	3	1	3	0	5	NA	NA	NA	NA
2011-05	1	1	0	2	0	0	0	0	NA	NA	NA	NA
2011-06	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2011-07	1	0	0	1	0	0	0	0	NA	NA	NA	NA
2011-08	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2011-09	NA	NA	NA	NA								
2011-10	0	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA
2011-11	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2011-12	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2012-01	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2012-02	0	0	0	0	0	0	0	0	0	9	4	13
2012-03	0	0	0	0	0	0	0	0	0	14	7	24
2012-04	0	0	0	0	0	0	0	0	3.5	9.5	6.5	19.5
2012-05	NA	NA	NA	NA								
2012-06	1	1	0	2	0	0	0	0	5	12	8	26
2012-07	NA	2	2	3	7.5							
2012-08	NA	NA	NA	NA								
2012-09	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2012-10	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2012-11	NA	NA	NA	NA								

2012-12	NA											
2013-01	0	0	0	0	0	0	1	1	NA	NA	NA	NA
2013-02	NA											
2013-03	0	0	0	0	0	3	0	3	NA	NA	NA	NA
2013-04	0	0	0	0	0	1	2	3	NA	NA	NA	NA
2013-05	0	1	0	1	0	0	2	2	NA	NA	NA	NA
2013-06	0	0	0	0	0	1	1	2	NA	NA	NA	NA
2013-07	0	0	0	0	0	1	2	3	NA	NA	NA	NA
2013-08	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2013-09	NA											
2013-10	NA											
2013-11	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2013-12	NA	0	2	2	5							
2014-01	NA	0	0	1	1							
2014-02	0	0	0	0	0	0	1	1	NA	NA	NA	NA
2014-03	NA	0	3	1	4							
2014-04	0	0	0	0	0	0	0	0	NA	NA	NA	NA
2014-05	NA											
2014-06	NA											
2014-07	NA											
2014-08	NA											
2014-09	NA											
2014-10	NA											
2014-11	NA											
2014-12	NA											
2015-01	NA											
2015-02	NA											
2015-03	NA											
2015-04	NA											
2015-05	NA											
2015-06	NA											
2015-07	NA											
2015-08	NA											
2015-09	NA											
2015-10	NA											
2015-11	NA											

2015-12	NA											
2016-01	NA											
2016-02	NA											
2016-03	NA											